REMARKS/ARGUMENTS

I. INTRODUCTORY REMARKS

This application is directed to a radio frequency motion tracking system that is capable of very high resolution over a wide capture area and using a large number of tags simultaneously. Applicants thank the Examiner for the Office Action of April 27, 2005 which has been studied with interest and care, and for the Examiner's time and courtesy granted in the examiner interview of July 11, 2005.

In the interview, the Applicants discussed a number of claim limitations in the claims as filed, as well as proposed additional claim limitations, which distinguish Applicants' invention over the prior art. The purpose of the interview was not to attempt to reach agreement on the day of the interview, but for Applicants to present orally some of the arguments in favor of patentability that Applicants anticipated presenting in greater detail in this Response.

Claims 1-73 are pending in the application.

Claims 43-53 are withdrawn from consideration; the Examiner, however, has indicated that claims 9-10 and 18 link(s) the elected Group I claims (claims 1-42 and 54-73) and the unelected Group II claims (claims 9-10, 18, and 43-53), such that upon allowance of the linking claim(s) the restriction requirement as to the linked inventions shall be withdrawn and any claim(s) depending from or otherwise including all the limitations of the allowable linking claim(s) will be entitled to examination in the instant application.

Claims 1-42 and 54-73 are rejected in view of the prior art. Specifically:

Claims 1-3, 6, 11, 14-16, 19, 21-23, 29-32, 34-40, 66, 68-69, and 72-73 are rejected under 35 U.S.C. § 102(b) as being anticipated by Boyd (US 6,380,894) including Belcher (6,121,926) which is incorporated by reference into Boyd;

Claims 29-31, 66, and 73 are rejected under 35 U.S.C. § 102(b) as being anticipated by Daver (US 5,513,854);

Claims 4, 7-8, 24, 27-28, 54-65, and 67 are rejected under 35 U.S.C. § 103(a) as being obvious over Boyd in further view of Kivolowitz (US 5,881,321), or, alternatively, over Kivolowitz in view of Boyd;

Claims 5 and 25-26 are rejected under 35 U.S.C. § 103(a) as obvious over Boyd and Kivolowitz, and in further view of Maeda (US 6,359,621) and Katzenberger (US 5,867,175);

Claims 9-10 and 18 are rejected under 35 U.S.C. § 103(a) as obvious over Boyd in further view of Jeon (US 6,524,734);

Claims 12-13 and 33 are rejected under 35 U.S.C. § 103(a) as obvious over Boyd in further view of Dierendonck (2001 Powerpoint document entitled Planned GPS Civil Signals and their Benefits to the Civil Community, obtained from Internet);

Claims 17 and 41-42 are rejected as obvious over Boyd in further view of any one of Aman (US2003/0095186), Cameron (US 6,669,571), and Rodman (US 1,983,402);

Claims 20 and 70-71 are rejected under 35 U.S.C. § 103(a) as obvious over Boyd in further view of Panasik (US 2003/0122711) and Allison (US 5,148,179);

Claim 33 is rejected under 35 U.S.C. § 103(a) as obvious over Boyd; and

Claims 32 and 69 are rejected under 35 U.S.C. § 103(a) as being obvious over Daver.

The Examiner also finds Romanoff (6,820,980) to be similar to Kivolowitz, and further states that Wang, Shioda, Rabinowitz '518, and Rabinowitz '565 all disclose ground based pseudorange positioning systems.

Claim 35 is also objected to as lacking in antecedent basis for the limitation "the marker tag" in line 5.

By this amendment, a number of the claims have been amended to more clearly define Applicants' contribution to the art. Additionally, the specification has been amended as required by the Examiner, a spelling error in the specification has been amended, claims 4-6 have been amended to more properly depend from method claim 18 rather than apparatus claim 1, and claims 15-16 and 38 have been amended to remove unnecessary limitations.

Reconsideration of the application in view of the amendments and the following remarks is respectfully requested.

II. AMENDMENTS TO THE SPECIFICATION

Paragraph 1 has been amended to refer to the now-issued parent patent as required by the Examiner.

Paragraph 7 has been amended to correct a typographical error in the listing of a prior art patent as required by the Examiner.

Additionally, paragraph 9 has been amended to correct a spelling error.

III. MINOR AMENDMENTS TO THE CLAIMS

Claim 35 has been amended to provide proper antecedent basis for all limitations recited. Applicants thank the Examiner for the guidance provided in that regard.

Claims 4-6 as originally presented recited "The method of claim 1 . . . " That was incorrect because claim 1 is an apparatus claim rather than a method claim. To correct this error, claims 4-6 have been amended to depend from claim 18 which is a method claim.

IV. DISCUSSION OF THE BOYD REFERENCE PRIOR ART

The principal reference relied on by the Examiner is Boyd. A detailed discussion of that reference will be helpful before discussing the claims.

The Boyd patent purports to be an "augmentation to a geolocation system of the type described in the above-referenced Belcher Patents [Pat Nos. 5,920,287 and 5,995,046] and '710 application [apparently 09/442,710 now Pat. 6,121,926]," (Boyd at col. 4, lines 51-54, referencing col. 2, line 18 and col. 1, lines 13-14), using the same tags as used in those patents (col. 4, lines 54-56). Boyd purports to add one or more reference tags of the same type as used as object tags in the Belcher patents (col. 4, lines 54-56), with the reference tag(s) being placed "**at locations within the environment whose geo-coordinates are very precisely known**." (Boyd, col. 4, lines 58-59) (emphasis added) (see also col. 5, lines 58-60, requiring that the reference tags be locked at "precisely known coordinate locations.") The tag emission readers are also **"installed at fixed geographic locations, whose longitude and latitude coordinates are precisely known."** (Boyd, col. 5, lines 32-34) (emphasis added) By adding the reference tag(s) at precisely known locations and with reference to tag readers that are also placed at precisely known locations, Boyd purports to be able to effectively measure the transport delays through the electronics and cabling (the "cable plant" delays), and thus to increase the accuracy of the Belcher system (see Summary of the Invention generally; see also col. 6, line 53 – col. 7,

line 5) which uses standard time-of-arrival measurements and triangulation algorithms (col. 3, lines 26-31).

To further understand Boyd and the limitations of its teachings, Applicants note that Belcher US 5,920,287, which forms the basis of the Boyd system, itself purports to be an improvement on Heller US 5,119,104 (Belcher at col. 1, line 23; col. 1, line 52; col. 2, line 2; and col. 2, line 19). As described within Heller, "Each receiver includes a **time-of-arrival circuit** and a data communications TAG transmission, providing a time-of-arrival TOA-COUNT **synchronized to a system synchronization clock available at each receiver**." (Heller, col. 2, lines 14-16) (emphasis added) (see also, e.g., claim 1 (("with the TOA count being synchronized to a system synchronization clock provided to each receiver")) Indeed, Belcher itself states that the Belcher system requires "**a highly stable reference frequency signal** . . . coupled over a (75 ohm) communications cable 231 **from a control processor.**" (col. 7, lines 59-61) (emphasis added) . This centrally controlled synchronizing signal is shown in Fig. 5, which is reproduced below for the examiner's reference. According to the figure, the Reference Signal comes from outside the receiver.

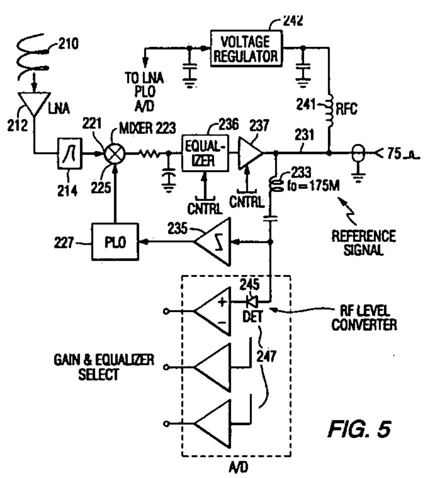

FIG. 5

Fig. 5 of Belcher (US 5,920,287).
This figure shows the centrally controlled Reference Signal input to the receivers.

This is consistent with the more detailed description in Heller of reliance upon synchronized receiver clocks.

Additionally, as repeatedly stated by Belcher, the Belcher system is capable of a spatial resolution "to within only a few feet" (col. 3, line 24), i.e., "**on the order of ten feet**" (col. 5, line

17) (emphasis added). Boyd does not claim any specific improvement in accuracy over the Belcher system.

Boyd is therefore a system which requires that the tag readers and the reference tags all be placed at locations whose coordinates are precisely known "*a priori*" (col. 6, line 6), which also requires synchronization of receiver clocks from a central controller, and which further produces tag location measurements which may (or may not be) some unspecified amount better than "on the order of ten feet."

These aspects of Boyd contrast with the present invention in which the sensors and reference tags can be placed at arbitrary locations and those positions then determined with great accuracy using an automatic calibration procedure (see, e.g., paragraph 128), does not require synchronization of clocks (see paragraph 17), and is accurate to within 1 cm over a capture zone of at least 75 meters (see paragraph 20).

Details of other cited art will be discussed below in relation to the specific claims to which those references have been applied.

IV. CLAIM REJECTIONS, AND AMENDMENTS MADE IN RESPONSE THERETO

The claim rejections will now be discussed in detail, along with arguments in favor of patentability including discussions of any amendments made in the claims in order to clarify the invention.

A. REJECTION OF CLAIMS UNDER 35 U.S.C. SECTION 102(b)

Claims 1-3, 6, 11, 14-16, 19, 21-23, 29-32, 34-40, 66, 68-69, and 72-73 are rejected under 35 U.S.C. § 102(b) as being anticipated by Boyd (US 6,380,894) including Belcher (6,121,926) which is incorporated by reference into Boyd.

1. Claim 1

Claim 1 has been amended to recite that the first radio frequency transmitter (the reference tag) is disposed at an "arbitrary" position relative to the receivers rather than a determinable position, and that the positions of the other transmitters (the object tags) are determined "relative to the position of the first transmitter at said arbitrary position." The amendment is supported in the specification at, e.g., paragraph 82 ("[T]he system provides

marker tag position outputs in X, Y, Z local level coordinates relative to the location of fixed reference tag 50 placed within the capture zone."); and at paragraph 16, lines 8-11 ("The positions of the reference tag relative to the sensors can be determined using direct measurements or can be determined using various possible calibration procedures and techniques which do not rely upon direct measurements.") and paragraphs 114 and 128-129.

Claim 1 as amended distinguishes over the cited Boyd system in which the reference tags must be placed "**at locations within the environment whose geo-coordinates are very precisely known**" (col. 4, lines 58-59) (emphasis added) (see also col. 5, lines 58-60, requiring that the reference tags be at "precisely known coordinate locations") and in which "the tag emission readers are also "**installed at fixed geographic locations, whose longitude and latitude coordinates are precisely known**" (col. 5, lines 32-34) (emphasis added).

2. Claim 2

Claim 2 has been amended to clarify that the means for determining the reference tag position relative to the receivers is a means for "automatically determining" that value. The amendment is supported in the specification at, e.g., paragraph 16, lines 8-11 ("The positions of the reference tag relative to the sensors can be determined using direct measurements or can be determined using various possible calibration procedures and techniques which do not rely upon direct measurements") and paragraphs 114 and 128-129.

The claim as amended clearly distinguishes over Boyd, which requires that the reference tags be "place[d] . . . at locations within the environment whose geo-coordinates are very precisely known." (col. 4, lines 55-59)

3. Claim 3

Claim 3 recites that "the stationary receivers do not have circuitry which synchronizes their receiver clocks from one stationary receiver to another."

In rejecting the claim as anticipated, the Examiner states that Boyd discloses that "the stationary receivers do not have circuitry which synchronizes their receiver clocks from one stationary receiver to another (abstract; col. 5, lines 60-64)." (Office Action at p. 5)

Applicants respectfully disagree. The Boyd abstract does not disclose such a feature, and col. 5, lines 60-64 merely disclose that the tags randomly "blink," i.e., that the *tags* turn on and off at random times. This does not constitute a teaching that the clocks in the *receivers* are not

synchronized (nor even that the clocks in the tags that determine phasing of the transmitted waveforms, are not synchronized).

Furthermore, as the Examiner has pointed out, Boyd incorporates the teachings and the construction details of Belcher by reference. Belcher is a time-of-arrival based system that purports to be an improvement on Heller US 5,119,104 (Belcher at col. 1, line 23; col. 1, line 52; col. 2, line 2; and col. 2, line 19), which teaches that in that time-of-arrival based system, "Each receiver includes a **time-of-arrival circuit** and a data communications TAG transmission, providing a time-of-arrival TOA-COUNT **synchronized to a system synchronization clock available at each receiver**." (Heller, col. 2, lines 14-16) (emphasis added) (see also Heller claim 1 ("with the TOA count being synchronized to a system synchronization clock provided to each receiver")) Nowhere does either Belcher or Boyd state that their systems are departing from the Heller system by using a different basic system than the time-of-arrival measurement system of Heller. Nowhere does Boyd or Belcher state that their systems do not rely on synchronized receiver clocks as the Heller system explicitly does.

4. Claim 6

Claim 6 was rejected as obvious on the basis that Boyd/Belcher show use of the system in a product manufacturing process.

Claim 6 has been amended to clarify that recite that the tags are on two [absolutely] moving objects and to recite the step of "using said determined position information to analyze interaction between said moving objects within said product manufacturing process." The amendment to the claim is supported in the specification at, e.g., paragraph 190.

The claim as amended distinguishes over the Boyd/Belcher references, which merely disclose that their system can be used for "asset management," i.e., tracking bulk movement of objects on an assembly line, shipping containers, people, vehicles, and the like. Indeed, a system which is accurate to only within a few feet would be useful only for such bulk asset tracking.

In contrast, the extremely high accuracy of the present system allows not only the gross movement of assets to be tracked as in the prior art, but also enables precise analysis of interaction between quickly moving parts.

5. Claims 7, 54-58, 61-65, and 67

Claims 7, 54-58, 61-65, and 67 are rejected as obvious over Boyd in further view of Kivolowitz, or alternatively over Kivolowitz in view of Boyd. The Examiner states that Kivolowitz teaches a "plurality of transmitters affixed thereto compris[ing] at least 3 transmitters disposed at positions on the camera sufficient to determine pitch, yaw, and roll of the camera (Fig. 1; col. 3, lines 36-45).

Applicants respectfully disagree. Kivolowitz teaches using inertial sensors comprising three gyroscopes and three accelerometers (col. 3, lines 36-40 and 48-51) to detect rotational and linear acceleration. The information obtained from those inertial sensors is then transmitted to a remote location for processing. This is vastly different from Applicants' system as defined in claims 7, 54-58, 61-65, and 67 in which an RF position sensing system (not an inertial acceleration sensing) is used to detect the pitch, yaw, and roll of the camera. It would not have been obvious to try to adapt Boyd's system for detecting camera movement because, as discussed in greater detail above, Boyd's system is nowhere nearly accurate enough for camera tracking, which requires great positional accuracy (for determining rotational data) if the data produced is to be of any use whatsoever. It is only the Applicants who have suggested that an RF position sensing system might be made accurate enough for camera tracking and it is Applicants who determined how to make an RF position sensing system that meets that demanding standard for positional accuracy which Boyd's system appears to be wholly inadequate to meet.

6. Claims 8 and 59-60

The same arguments as presented above with respect to claims 7, 54-58, 61-65, and 67 apply with even greater force to claims 8 and 59-60, which are directed to using the Applicants' RF motion tracking system to sense movement of a hand held camera, and using the positional data computer in order to remove camera jitter. It would not have been obvious to use Boyd's coarse position sensing system to track movement of a hand held camera to remove camera jitter. Removing camera jitter would require accuracy to within approximately a millimeter, not to within the a few feet. Boyd's system would be inoperative to remove camera jitter because Boyd's system would not be nearly accurate enough.

7. Claim 19

Claim 19 is rejected as anticipated by Boyd.

Applicants traverse the rejection. Amended claim 19 now recites the steps of:

at the sensors, determining relative phase information between the signal received from the reference tag and signals received from the marker tags; and

processing the relative phase information determined at the sensors to determine respective positions of the marker tags.

The cited Boyd reference uses time-of-arrival calculations, apparently relying upon the receiver clocks all being synchronized in order to determine the respective arrival times as discussed above. Boyd does not disclose determining such relative phase information between the reference tag sensor and the object tags, and using that relative phase information to determine the respective positions of the marker tags as claimed. The claim as amended is novel and nonobvious over the cited art.

8. Claim 23

Claim 23 depends from claim 19, and adds the limitation of "determining a code phase indicating the position of a given marker tag to within a range corresponding to a bit position of [a] synchronization code." The Examiner has not pointed to where Boyd discloses this subject matter within the cited reference nor any reference, nor explained why it would be obvious from reading Boyd to employ such a processing step. The undersigned has studied the Boyd reference with care, and has found no disclosure or suggestion of the subject matter of claim 23.

9. Claim 35

The Examiner rejected independent claim 35 as anticipated by Boyd, but did not discuss the subject matter specifically recited in claim 35.

In response to the rejection, Applicants have amended the claim to specifically recite that the reference tag is placed "at a not precisely controlled position," that the tags signals are both received and "digitize[ed]," and that the signals received from the tags are processed to determine positions of the object "relative to the reference tag" as the object moves through the capture zone. This subject matter is neither disclosed nor suggested by the Boyd reference. Boyd in fact strongly teaches away from this subject matter, because Boyd requires "placement of . . . one or more reference tags . . . at locations . . .whose geo-coordinates are very precisely known." (col. 4, lines 55-59)

As correctly noted by the Examiner during the examiner interview of July 11, 2005, and as referenced by the Examiner in his Interview Summary Record, the specification states at one

point that the sensors "are placed at known locations" (paragraph 16, lines 5-6). However, as the specification clarifies, that is merely one manner or embodiment of using the system. Specifically, "The positions of the reference tag relative to the sensors can be determined using direct measurements or can be determined using various possible calibration procedures and techniques which do not rely upon direct measurements." (paragraph 16, lines 8-11) See also paragraphs 114-116, 128, and 147 for further discussion of calibration procedures.

Furthermore, claim 35 as amended clarifies that the positions of the marker tags are determined "relative to the reference tag" as the object moves through the capture zone. The amendment is supported in the specification at, e.g., paragraph 82, lines 1-3, and paragraph 103, lines 2-5. Processing the signals in a relative coordinate system as recited frees the system from needing to determine absolute positions; instead, only relative positions need be determined, rendering the system much more flexible than the Boyd system.

The cited Boyd reference neither teaches nor suggests processing the signals to determine the position of the object tags relative to the reference tag. Rather, Boyd merely adds the reference tag at a precisely known location as a tool to help calibrate plant delays, thus purportedly providing some unspecified increase in accuracy over Belcher's system which uses no reference tag and which was accurate to only within "on the on the order of ten feet." (col. 5, line 17)

10. Claims 11, 14-15, 21-22, and 37

Claims 11, 14-15, 21-22, and 37 are rejected as anticipated by Boyd. The Examiner states that Boyd "discloses each of the transmitters affixed to the object transmits a synchronization coded and a tag identification code, the tag identification code being unique to each tag, the synchronization code and the tag identification code being modulated onto a carrier frequency (col. 5, lines 27-31)."

Applicants respectfully disagree for several reasons. First, the cited passage in Boyd merely discloses that each tag transmits spread spectrum RF bursts that are encoded with "the identification of the object to which the tag is attached."

a. Claims 11 and 21

The cited passage does not disclose, and the undersigned cannot find any disclosure or suggestion in Boyd, that the tags transmit a synchronization code as recited in claim 11. Claim 11 therefore clearly defines over the cited reference.

Claim 21 recites similar subject matter, and defines over the prior art for the same reasons as does claim 11.

b. Claims 15-16

Claims 15-16 have been amended to remove unnecessary limitations by rewriting them to depend from claim 1 rather than claim 11.

Claim 15 recites that the "tag identification codes . . . are vectors in a binary extended quadratic residue code space." This subject matter is not disclosed by the cited reference, and the undersigned has found no suggestion of that subject matter therein.

Claims 16 recites a particular code generator polynomial used to produce the tag identification codes. That subject matter is not disclosed by the cited reference, and the undersigned has found no suggestion of that subject matter therein.

c. Claim 37

Claim 37 is rejected as anticipated by Boyd. No specific statement was given how Boyd anticipates the limitations of claim 37.

Independent claim 37 recites that the received waveforms are associated with the respective marker tags from which they were transmitted "without demodulating the waveforms to respective bit patterns." This is important subject matter that the reference does not disclose, and in fact appears to positively teaches away from. Specifically, Belcher teaches that in order to identify a particular tag, the received waveform should be processed to produce "tag identification bit contents," which is then compared to the "stored tag identification code." (Col. 7, line 32) In contrast to the standard technique of extracting the binary tag identification code from the received waveform in order to identify the transmitting tag, the Applicants identified a method for matching the received waveforms to their respective transmitters *without needing to first reconstruct the patterns of 1's and 0's that was transmitted,* as was done in prior art systems. By doing so, the Applicants have significantly increased the throughput capabilities of the system. This allows the same system to either track a significantly greater number of tags, and/or to run more sophisticated position-determining algorithms thus increasing the spatial resolution of the system. This is a significant advance. The recited subject matter is neither disclosed nor suggested by the reference. Claim 35 patent distinguishes over the cited art.

11. Claims 29, 36, and 66

a. Rejections Over Boyd

Claims 29-32, 36, 66, 68, 69, and 73 are rejected as anticipated by Boyd, on the stated ground that "Boyd discloses neither the transmission of the signal nor the receiving of the signal at a given receiver is controlled in time with respect to any of the other receivers (abstract; 1st sentence; col. 5, lines 60-64). Belcher discusses in more detail the tag's random/uncontrolled transmission times (e.g. col. 2-4)."

Applicants agree that Boyd and Belcher both employ systems in which the transmitter tags randomly "blink," i.e., their transmissions times include random on/off patterns. Applicants even agree that in the referenced systems, the transmitter tags do not appear to have synchronized clocks, which is a different issue from whether their on/off times are random.[1] What Boyd and Belcher teach, however, is that although the tags can transmit randomly, the receivers must be synchronized. Belcher teaches that the intermediate frequency oscillator at each receiver "is driven by a highly stable reference frequency signal . . . coupled over a (75 ohm) communication cable 231 *from a control processor*" (emphasis added).

In order to clarify this distinction over the prior art, claim 29 has been amended to recite that "the processing of the signal at a given receiver is [not] controlled in time with respect to any of the other receivers." Similarly, claim 36 has been amended to recite that "the receiving steps performed at the sensors are not synchronized with respect to the other sensors." Claims 29 and 36 as amended clearly define over the cited references which rely on synchronized receivers.

Claim 66, which has not been amended, recites that the system operates "without requiring timing clocks of either the transmitters or the receivers to be synchronized." The claims distinguishes over the prior art without requiring any amendment.

b. Rejections Over Daver

Claims 29-31, 66 and 73 are rejected as anticipated by Daver (5,513,854).

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[1] Different tags could employ synchronized clocks all controlled from a central location in order to generate waveforms, the phases, starting bit positions, or starting word positions of which are carefully controlled in time, while still "blinking" (the transmissions starting and stopping) randomly.

Daver discloses a system for tracking persons in motion, which uses "goniometric receivers" to perform "known triangulation methods." (Col. 4, lines 42-46) That is, Daver employs classical telemetry using direction-finding receivers and triangulation.

With respect to independent claim 29, Applicants agree that classical telemetry using direction-finding receivers and triangulation uses receivers that are not synchronized with each other. In order to clarify Applicants' invention over the cited art, Applicants have amended claim 29 to add that the signal processes "phase and pseudorange measures of the signals received." Claim 29 now clearly distinguishes over Daver.

Independent Claim 66 distinguishes over Daver, because claim 66 requires that the position determining is performed "based on *timings* of signals received from the transmitters." In contrast, the goniometric (direction-finding) receivers determine the directions from which the signals are received, and the position of the transmitter is then determined from those directions using classic vector triangulation.

Claim 73 distinguishes over Daver at last because claim 73 recites the use of "spread spectrum" signals, whereas Daver relies on classic telemetry and triangulation. There is no disclosure in Daver of using spread spectrum. Daver, in fact, teaches away from using spread spectrum ("Every transmitter transmits a common radio frequency carrier within the 223.5 Mhz or 2.4 Ghz bands . . ." (col. 4, lines 53-54))

12. <u>Claims 68 and 68</u>

Claims 68 and 69 are rejected as anticipated by Boyd.

Claim 68 recites "means for resolving positions of at least 100 transmitters to within 1 cm of accuracy over a capture zone having a diagonal of at least 50 meters." Claim 69 recites a means for achieving even greater performance.

The Examiner has not pointed to any teaching in Boyd that constitutes means for achieving such high positional accuracy, such a wide capture zone, and accommodating such a large number of transmitters. Nowhere does Boyd even purport to be able to achieve such performance, as he only claims that his system represents some unspecified augmentation of Belcher's system which is capable of only a spatial accuracy of "on the order of ten feet." (col. 5, line 17)

Indeed, Applicants believe that the Boyd system would not come close to achieving such performance numbers. It is Applicants that have disclosed, in the very detailed disclosure in the

specification, a means for accomplishing such results. The claims are therefore novel and nonobvious over the cited art.

13. Claim 38

Claim 38 is rejected as anticipated by Boyd. The Examiner states that Boyd "discloses the waveform processing includes correlating sampled values of each of the received waveforms against samples of stored tag identification code waveforms; and identifying a particular marker tag as the marker tag that transmitted a particular received waveform based on a high correlation between samples of said particular received waveform and a particular stored tag identification code waveform (col. 2, lines 42-49)."

Applicants respectfully disagree. The cited passage within Boyd merely discloses that the correlation is used to determine which of the received signals within the multipath environment to which Boyd is directed was the first-to-arrive. The cited passage from Boyd is, in fact, a condensed version of the following passage in the Belcher reference which forms the basis of the Boyd system:

> Spread spectrum signals emitted by a tag and detected by a respective reader are coupled to an associated **correlation-based RF signal processor to determine which spread spectrum signal received by the reader is the first-to-arrive signal from that tag--namely, that burst which has travelled over the closest observable path** from the tag to the reader. As each reader can be expected to receive multiple signals having different amplitudes and times of arrival, due to **multipath effects** caused by the burst emitted by the tag being reflected off various objects/surfaces between the tag and the reader, the use of correlation signal processing ensures identification of the first observable transmission, which is the only signal containing valid timing information from which a true determination can be made of the distance from the tag to the reader.

(Belcher at col. 2, lines 36-51)

That is, Boyd only teaches uses the correlation to pick out from among all of the different received signals the non-reflected version of the transmission rather than the multipath (reflected) versions. Boyd does not disclose or suggest "identifying a particular marker tag . . . based on a high correlation between said samples of said particular received waveform and a particular stored waveform" as claimed. The claim therefore patently distinguishes over the prior art.

14. Claim 40

Claim 40 is rejected as anticipated by Boyd. The Examiner states that Boyd "discloses the stored tag identification code waveforms have been filtered to approximate an idealized tag identification code waveform as it would actually be received at said sensors (Belcher: 307, Fig. 6; col. 6, lines 65 to col. 7, line 62)."

Applicants respectfully disagree. The undersigned has carefully studied the cited 65 lines of text, but can find no disclosure of distorting an idealized waveform according to the expected overall transmit-to-receive transfer function, storing that distorted tag waveform *as it would actually be received at the sensors*, and then using that distorted waveform pattern to compare against received waveforms in order to increase the correlation accuracy and decrease the correlation time compared to a system that uses idealized waveforms, as claimed in claim 40. Applicants therefore submit that claim 40 represents novel and nonobvious subject matter that patentably distinguishes over the cited art.

B. REJECTION OF CLAIMS UNDER 35 U.S.C. SECTION 103(b)

1. Claims 4, 7-8, 24, 27-28, 54-65, and 67

Claims 4, 7-8, 24, 27-28, 54-65, and 67 are rejected as obvious over Boyd in further view of Kivolowitz, or, alternatively, over Kivolowitz in view of Boyd.

a. Claim 4

Claim 4 recites that the radio frequency motion capture system is used "to position a computer generated object within a motion picture scene."

The Examiner states that it would be obvious to modify Boyd's RF motion tracking system so that it can be used on a camera to track movement of the camera, for the purpose of positioning computer generated images within a motion picture scene at taught by Kivolowitz (US 5,881,321).

Applicants respectfully disagree. Kivolowitz discloses using inertial sensors to track movement of a camera to facilitate generation of images that are consistent with the scene being recorded. Inertial sensors are highly accurate, capable of detecting movements to within small fractions of a degree of rotation and small fractions of g's in acceleration. Such accuracy would be necessary in order to record pitch, yaw, and roll of a camera with high accuracy and to

correctly place the computer generated image (CGI) in the captured video scene. In order to replace gyroscopes with XYZ positional sensors such as RF motion tracking sensors, would require an RF system capable of probably on the order of about one millimeter spatial resolution.

The Belcher system on which the Boyd system is based states that it is accurate "to within only a few feet" (col. 3, line 24), i.e., "on the order of ten feet" (col. 5, line 17) (emphasis added). Such a spatial resolution would be grossly inadequate for recording pitch/yaw/roll of a camera and hence placement of a CGI within a filmed scene. Boyd gives no hint that his system would have the extremely high accuracy that would be needed for CGI correlation, such as the very high accuracy of Applicants' system (see paragraph 20). It appears that Boyd's system would in fact be so inaccurate as to be entirely useless for such an application. Applicants respectfully submit therefore that it would not have been obvious to combine Boyd and Kivolowitz, which would assuredly result in a nonfunctional system. The Examiner states that inertial sensors develop errors over time. (Office Action at p. 9) While it is certainly true that inertial sensor errors accumulate, that problem is typically dealt with by allowing inertial system to perform zero-velocity updates (see, e.g., U.S. Patent No. 6,292,751 at Abstract). Even if the camera were shooting continuously for such a long time that performing zero-velocity updates was not an option, the Boyd system still provides no hint that it is capable of the pinpoint accuracy that would be required in order to apply Boyd's system to Kivolowitz's camera sensing system for CGI generation.

b. <u>Claims 5, and 25-26</u>

Claims 5, 25, and 26 recite using the Applicants' RF position tracking system to position CGI's within movies, video games, and virtual reality simulators, respectively. The Examiner has rejected the claims as obvious over Boyd and Kivolowitz, and further in view of Maeda (US 6,359,621) and Katzenberger (US 5,867,175).

Applicants respectfully disagree. Nowhere does Boyd disclose or suggest that his RF motion tracking system would have sufficient spatial accuracy to be used for generating CGI images for movies, video games, or virtual reality simulators. Such spatial accuracy – within the neighborhood of centimeters at least - would be critical to generating sufficiently pleasing animated CGI images. Indeed, it would appear that Boyd's system would be incapable of such spatial accuracy. Accordingly, Boyd's system would be non-functional for CGI generation. It would therefore not be obvious to try to use Boyd's system as the basis for CGI generation.

Furthermore, neither Maeda nor Katzenberger appear to disclose generation of images for use in virtual reality simulators as claimed in claim 26.

c. Claim 54

Independent claim 54 has been amended to recite the step of "processing phase information extracted from signals received from the camera transmitters to the at least four wireless radio frequency receivers to determine movement of the camera." Claim 54 as amended distinguishes over the combination of references cited for at least the reasons that neither reference discloses extracting phase information to determine positional information, and because the Boyd position tracking system is neither disclosed as being, nor would be, nearly accurate enough for useful camera motion detection, as discussed more extensively in Section IV above, and therefore it would be not only non-obvious, but in fact non-functional, to combine the references in the manner suggested by the Examiner.

d. Claim 61

Independent claim 61 as currently amended is similar to claim 54, in that claim 61 recites "a first processing section for . . . determining phase difference information relative to the respective transmitted signals as received at the receivers, and for determining from the phase difference information the movement of the camera." Claim 61 as amended distinguishes over the cited combination of references for at least the reasons stated with respect to claim 54.

2. Claims 9-10 and 18

Claims 9-10 and 18 are rejected as obvious over Boyd in further view of Jeon (US 6,524,734). The Examiner states that it would have been obvious to use the method of Jeon ("removing a backing layer and exposing an adhesive layer activating a device (col. 1, lines 28-32)") in order to save battery power by activating the transmitters when they are ready to be used for positioning.

Applicants respectfully disagree. Jeon relates to a metal-air battery generally called a coin cell (col. 1, lines 7-8). The purpose of the Jeon structure is to "improve current drain, shorten activation time after peeling off the seal sticker and maximize battery life by creating a system of gas diffusion passages which provide air chambers between the cathode container and the cathode." (col. 1, lines 39-43) There is no suggestion or motivation within either of the cited references to use a metal-air battery for the transmitters of the Boyd system.

Nevertheless, in order to clarify the claimed invention, Applicants have amended claim 10 to clarify that the transmitter has "an adhesive layer on the transmitter covered by the backing layer," such that removing the adhesive layer "leav[es] the transmitter operational and ready to adhere to an object." Claim 18 as amended is similar. The claims as amended would not be obvious in view of the cited references, at least because there is no disclosure or suggestion in Jeon that the battery cell should be the sticky part after the protective strip is removed such that the battery can be adhered to an object directly via the adhesive. It is Applicants who have realized the advantages of a patch tag in which peeling away a protective strip both activates the device and at the same time leaves the patch tag immediately ready for sticking to whatever object is to be tracked. Accordingly, claims 10 and 18 as amended patentably define over the prior art. Claim 9 has been cancelled.

3. Claims 17 and 41-42

Claims 17 and 41-42 are rejected as obvious over Boyd in further view of any one of Aman (US2003/0095186), Cameron (US 6,669,571), and Rodman (US 1,983,402). The Examiner states that Boyd fails to disclose the transmitter transmission rate is an integer multiple of 24 tps and 30 tps, or a transmission rate of 240 tps, but that Aman (¶ 132), Cameron (col. 13, lines 26-29) and Rodman (p. 5, col. 1, lines 31-59) disclose a transmission rate that is both an integer multiple of 24 tps and 30 tps, and 240 tps, to have a transmission rate high enough to capture real-time events, such as a hockey game.

Applicants respectfully disagree. Aman relates to an optical (light reflective) tracking system (see Abstract, and paragraphs 44-46) which is entirely different from an RF motion tracking system. The cited passage in Aman merely states that, "the present invention, camera and video capture technology can presently handle upwards of 240 frames per second with acceptable 1 megapixel resolution." Stating that an optical tracking system can handle up to 240 frames per second does not constitute a teaching or suggestion that in an RF tracking system there would be advantages to having the tag RF transmitters transmit at a frequency that is a multiple of 24, 30, and 120 tps.

Cameron relates to a video system for capturing high speed video footage of a golfer swinging a club in order to analyze his swing. There is no mention of RF motion tracking. The cited passage merely discloses the usefulness of a high speed video camera in which images are recorded at speeds $\geq$ 240 frames per second. This does not constitute a teaching or suggestion

that in an RF tracking system there would be advantages to having the tag RF transmitters transmit at a frequency that is a multiple of 24, 30, or 120 RF transmissions per second.

Rodman relates to a video camera system for producing motion pictures in natural colors. The cited passage merely discloses that high speed video cameras are available on the market, and in Rodman's system the first three consecutive exposures must be made at a rate of 240 frames per second. This does not constitute a teaching or suggestion that in an RF tracking system there would be advantages to having the tag RF transmitters transmit at a frequency that is a multiple of 24, 30, or 120 RF transmissions per second.

Accordingly, Applicants respectfully submit that claims 17 and 41-42 as presented patentably distinguish over the cited art.

4. Claims 20 and 70-71

Claims 20 and 71-71 are rejected as obvious over Boyd in further view of Panasik (US 2003/0122711) and Allison (US 5,148,179). The Examiner states that, "Panasik discloses that it is well known for ground based positioning systems to use pseudorange positioning (¶¶ 41)," that, "Allison discloses a GPS method computer respective reference tag pseudorange measuresments and . . . solving simultaneous equations to compute the position of the marker tag (abstract)," and that it would have therefore been obvious to combine the reference to arrive at the system claimed.

Applicants respectfully disagree for several reasons. First, Panasik is a system that relies on "local broadcast signals" (title; abstract, lines 5-6) and "digital satellite relay transmitters . . . [which] are already synchronized to GPS time," and which has three different embodiments, one of which requires synchronized transmitters, and the other two of which require a supplemental local monitoring unit (LMU) to determine and send timing errors of local transmitters (¶ 15). Those features make the Panasik system entirely unlike the claimed system which uses tags and sensors as recited in claim 20 (rather than broadcast signals and satellite relay transmitters), and which uses non-synchronized transmitters and non-synchronized receivers as recited in claims 70 and 71 (and in claim 66 from which claim 70 depends).

Second, Allison is a GPS system which uses satellite transmitters and passive receivers to determine the positions of the *receivers,* not the transmitters as in the claimed system. It is also crucial to note that in a GPS system such as the Allison system, the satellite transmitter clocks are all precisely synchronized, unlike in the claimed system.

Additionally, claims 66 (from which claims 70 and 71 depend), 70, and 71 are written in means-plus-function form. Claims written in this form are construed to cover the structures or methods disclosed in the specification and their equivalents. 35 U.S.C. § 112, paragraph 6. In examining the claim, the PTO must interpret the claim as meaning that which is disclosed in the specification and their equivalents. In re Donaldson Co., 16 F.3d 1189 (Fed. Cir. 1994). A claim cannot be rejected merely because the function performed by the prior art satisfies the function recited in the claim; rather, the specific structures or steps must be equivalent. Id.

In this case, the Panasik and Allison references relied upon do not perform the functions of "determining positions of the wireless transmitters" as recited in the claims. Furthermore, those references do not disclose any means for performing that function nor doing so "without requiring synchronization" as recited, that are equivalent to the means disclosed in the specification for performing those tasks, and for doing so without any carefully controlled transmitter synchronization (as in the case of Allison's GPS based system), or synchronized receivers or requiring supplemental LMU data (as in the Panasik system). With even greater force, those references do not disclose any such means that would be the equivalent (under, e.g., the tri-partite function/way/result test) of the disclosure in the specification for accomplishing those results.

Accordingly, Applicants respectfully submit that claims 20, 70, and 71 patentably distinguish over the prior art.

V. DEPENDENT CLAIMS NOT SPECIFICALLY DISCUSSED

Any claims not specifically discussed herein are dependent claims that patentably distinguish over the prior art for at least the reasons discussed with respect to those independent claims.

CONCLUSIONS

In view of the foregoing, it is respectively urged that all of the present claims of the application are patentable and in a condition for allowance. Notice of allowance is earnestly solicited. The undersigned attorney can be reached at 310-590-4528 to facilitate prosecution of this application, if necessary.

If any additional fees are required in connection with this paper that are not provided for herewith, or if any refund is due, the Commissioner is hereby authorized to charge any additional fees that may be due or to credit any refund to Deposit Account No. 50-3504.

Respectfully submitted,

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